Novel, Multidisciplinary Global Optimization under Uncertainty

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Under the Team-Based LEARN Phase I research project titled “Novel, Multidisciplinary Global Optimization under Uncertainty,” the Saab Sensis Corporation team will develop a new, innovative, computationally-efficient trajectory optimization tool called PROCAST (Probabilistic Robust Optimization of Complex Aeronautics Systems Technology) to generate globally optimal and robust solutions for complex systems problems characterized by three key attributes: multiple competing optimization-objectives, uncertainty impacts, and network effects.

PROCAST combines for the first time the attributes of modern developments in the disciplines of Data Science/Bayesian Probability Theory and Complex Adaptive Systems. PROCAST uses Bayesian Belief Networks—a probabilistic graphical model (a type of a statistical model) that represents a set of random variables and their conditional dependencies via a directed acyclic graph—for generating thousands of realistic forecasts of potential future trajectories. PROCAST uses NextGen Aerosciences’ (NGA’s) Continuous Replanning Engine (NACRE)—a complex adaptive systems-based method of constrained optimization—for fast optimization over each future trajectory forecast. PROCAST integrates Bayesian Belief Networks and NACRE in an innovative manner to provide a decision support capability for facilitating traffic management decisions under uncertainty.

We prove the viability/promise of PROCAST by applying it to an example Air Traffic Management (ATM) test-problem: multi-airport (metroplex) traffic scheduling, for managing arrival and departure traffic on the ground and in the terminal airspace under uncertainty. For this test, we enhance an existing NASA surface simulation tool to generate a metroplex arrival-departure-surface traffic simulation test-bed for supporting proof-of-viability experiments.